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Volney M. Spalding, Professor of Botany, University of Michigan, Ann Arbor, Mich.

Elmer A. Sperry, Electrical Engineer, 366-388 Massachusetts Avenue, Buffalo, N. Y.

Walter E. Spicer, M.D., 312 W. 51st Street, New York City.

Frank McM. Stanton, agent of Atlantic, Baltic and Central Mining Companies, Atlantic Mine, Houghton County, Michigan.

Robert Brewster Stanton, Civil and Mining Engineer, Sewickley, Pa.

Ralph Chambers Stewart, 1031 Spruce Street, Philadelphia, Pa.

Geo. M. Stiles, M.D., Conshohocken, Pa.

George H. Stoddard, Mechanical Engineer, 457 Marlborough Street, Boston, Mass.

Alfred H. Stone, Greenville, Miss.

Emil Swensson, Civil Engineer, 600 Lewis Block, Pittsburg, Pa.

Frank Stone Tainter, Civil Engineer, Far Hills, N. J.

Miss Mignon Talbot, Teacher of Physical Geography, East High School, Columbus, Ohio.

Arthur Davis Terrell, Chemist, 624 E. Madison Street, Iola, Kansas.

Jerome B. Thomas, Captain and Assistant Surgeon, U. S. V., care Chief Surgeon, Manila, P. I.

George Attwater Tibbals, 148 Milton Street, Brooklyn, N. Y.

E. B. Titchener, Professor of Psychology, Cornell University, Ithaca, N. Y.

Stonewall Tompkins, Mechanical Engineer, 1602 McKinney Avenue, Houston, Texas.

William C. Tucker, Civil and Sanitary Engineer, 156 Fifth Avenue, New York City.

August Uihlein, 332 Galena Street, Milwaukee, Wis.

Cornelius Vanderbilt, 602 Fifth Avenue, New York City.

Delos Lewis Van Dine, Normal School, Honolulu, H. T.

C. F. von Herrmann, Section Director, Weather Bureau, Raleigh, N. C.

F. von Ihering, Museo Paulista, Sao Paulo, Brazil.

Samuel Wagner, President of the Wagner Free Institute of Science, Philadelphia, Pa.

Charles M. Wales, Mechanical Engineer, 567 West 113th Street, New York City.

Coleman B. Waller, Vanderbilt University, Nashville, Tenn.

John Abbet Walls, 750 Main Street, Niagara Falls, N. Y.

John Daniel Walters, Professor of Industrial Art, Agricultural College, Manhattan, Kansas.

Frederic S. Webster, Carnegie Museum, Pittsburg, Pa.

Edgar A. Weimer, Mechanical and Blast Furnace Engineer, Lebanon, Pa.

Francis Ralston Welsh, 328 Chestnut Street, Philadelphia, Pa.

Francis W. Wenner, Superintendent of Public Schools, North Baltimore, Ohio.

Thomas S. West, Mechanical Engineer, Sharpville, Pa.

Lewis Gardner Westgate, Professor of Geology, Ohio Wesleyan University, Delaware, Ohio.

Henry Herman Westinghouse, Wilmerding, Pa.

Andrew J. Wiley, Civil Engineer, Boise, Idaho.

Elmer Ellsworth Wolfe, 313 Scammel Street, Marietta, Ohio.

Stuart Wood, 400 Chestnut Street, Philadelphia, Pa.

Miss Rosa L. Woodberry, Teacher of Natural Science, Luey Cobb Institute, Athens, Ga.

Fred A. Woods, M.D., Harvard Medical School, Boston, Mass.

J. S. Wooten, M.D., Austin, Texas.

Benjamin F. Yanney, Professor of Mathematics and Astronomy, Mt. Union College, Alliance, Ohio.

Clinton Mason Young, 387 School Street, Athol, Mass.

Walter Douglas Young, Electrical Engineer, B. & O. R. R., 309 Oakdale Road, Roland Park, Baltimore, Md.

SCIENTIFIC BOOKS.

Regeneration. By THOMAS HUNT MORGAN, Ph.D., Professor of Biology in Bryn Mawr College. Columbia University Biological Series, Vol. VII. New York, The Macmillan Company. 1901. Pp. xii+316; 67 text figures. Price, \$3.

The high character of the Columbia University Biological Series is more than maintained by its latest publication—Professor Morgan's book on 'Regeneration.' It is rare indeed to find a book which contains so large an amount of research work and which is at the same time of such general interest and importance. This is no mere description of the peculiar and bizarre 'dime museum experiments' of experimental zoology, but rather a thorough treatise on some of the most important methods and results of the new morphology.

To those who can read the signs of the times it is most evident that zoology has been passing through a period of revolution during the past ten years. A strong reaction has set in against the extremely speculative theories as to the factors of evolution, the inheritance or non-inheritance of acquired characters, and the whole 'phylogeny business' of a dozen years ago. The present attitude of most zoologists is more critical, less argumentative and in all respects more wholesome than prevailed when sky-scraping theories were erected on a single square foot of fact. In this wholesome reaction experimental morphology has played a most important part; in fact, it was the attempt to make biology an experimental science which first aroused interest in this subject, and while at times some of these experimental morphologists have illustrated the uncritical methods which they have denounced, while their conclusions have often been open to the criticism of having been hasty and ephemeral, no one can deny the fact that their work has introduced a new spirit into the study of zoology.

In this work the author has been one of the most productive and at the same time one of the most careful investigators. He saw, as apparently few others did, that the development of fragments of eggs and embryos was at bottom the same problem as the regeneration of parts of adult organisms, and during the past ten years he and his pupils have done a surprising amount of work on the regeneration of embryos and adults. There is probably no other living man so well fitted to treat this subject. To almost every topic discussed in the book, save the ones on regeneration in plants and on hypertrophy and atrophy, the author has made important original contributions. The literature list at the end of the book, which is very complete,* covering the most important papers on regeneration from the time of Aristotle to the present day, includes 470 titles, and one tenth of this total list has been contributed by Morgan and his pupils. As a result the discussion of each topic evinces a thoroughness of treatment and a ripeness of judgment which could come only from long and intimate acquaintance with

the problems involved. The book is therefore not merely a summary of the work which has been done on regeneration, but it is also a splendid contribution to knowledge.

In the fourteen chapters of the book the following subjects are presented: An historical and general introduction, the external and internal factors of regeneration in animals, regeneration in plants, a discussion of the supposed relation between regeneration and liability to injury, regeneration of internal organs, physiological regeneration, fission, budding and autotomy, grafting, origin of new cells and tissues, regeneration in egg and embryo, theories of development and of regeneration, general considerations on organization, vitalism and teleology. Of these topics the ones on regeneration and liability to injury, regeneration in egg and embryo, theories of regeneration and of development and the general considerations are of most general interest.

The greater part of the chapter on regeneration and liability to injury has already appeared in *SCIENCE*, and it need only be said here that Morgan has established in the most convincing manner the fact that there is no causal relation between the two, and that therefore it is impossible to regard the wonderful adaptations of regeneration as a result of the action of natural selection. It has long been recognized that natural selection is not so much a theory of evolution as an attempt to explain on causal grounds the remarkable and exquisite adaptations shown by living things. Nowhere are such adaptations more striking than in regeneration, and yet here it is in some cases quite certain that such adaptations cannot be attributed to the action of the Darwinian or of the Lamarckian principle. All theories which attempt to explain adaptations hold that they are due to experience; Lamarckism, that they are the direct result of use, disuse and need; Darwinism, that they are the indirect result of experience through the survival of the fittest. No theory yet advanced can explain adaptations to conditions never experienced before, and yet in the regeneration of animals there are adaptations which are undoubtedly of this sort. The

credit of first having shown the inability of natural selection to explain certain cases of regenerative adaptation belongs to Gustav Wolff rather than to Morgan, but the latter has greatly enlarged and extended the evidence in favor of this position. Nevertheless the author is conservative in his treatment of this question; he launches into no 'railing accusations' against natural selection, but is content to point out its insufficiency in the cases under discussion, wisely leaving others to draw their own conclusions as to its general applicability.

Likewise in his treatment of the theories of development and regeneration the author shows a wise conservatism which is in refreshing contrast to some of the revolutionary assertions of the earlier stages of *Entwicklungsmechanik*. The author's conclusion that regeneration and development belong to the same general group of phenomena and that the same problems are met with in the two is a most important and valuable one. His present position that the development of egg fragments is only a special case of regeneration plus the phenomena of development is fundamentally like the view expressed earlier by Roux ('93) and unlike the position which Driesch and Morgan formerly maintained. Thus he says (p. 247): "We have, however, no reason to suppose that all the (cleavage) cells are alike because they are all potentially equal. Even pieces of an adult animal—of hydra or of stentor, for example—can produce new whole organisms, although we must suppose these pieces to be at first as unlike as are the parts of the body from which they arise. Moreover we do not know of a single egg or embryo in which we cannot readily detect differences in different parts of the protoplasm." Contrast this with Driesch's famous dictum, 'By segmentation perfectly homogeneous parts are formed capable of any fate,' or with Morgan's former statement that 'the micromeres (of the sea-urchin egg) are undifferentiated blastomeres, and are not set aside to form any special organ, because normal embryos still come from such fragments without micromeres.'

The author finds the great problems of de-

velopment and regeneration centering in the determination of the causes of differentiation and these causes he finds in the organization. What this organization is, however, cannot be explained any more than the physicist can explain what gravity is. The author does not conceive this organization to be the outcome of the integration of biophores or other 'vital units,' nor can it be identified with cells. "Just as the properties of sugar are peculiar to the molecule and cannot be accounted for as the sum total of the properties of the atoms of carbon, hydrogen and oxygen of which the molecule is made up, so the properties of the organism are connected with its whole organization and are not simply those of its individual cells or lower units." The smallest pieces of organisms capable of regeneration are enormously larger than individual cells, and therefore 'the organization is a comparatively large structure.' It seems to me that in this matter the author loses sight of the fact that organization like individuality is a thing of degrees and stages. There is undoubtedly such a thing as the cell organization and this is capable of performing certain functions; whether or not it is able to perform the function of regeneration depends upon the animal in question. In protozoa and the egg cells of metazoa it is capable of regeneration as well as of all other functions; in adult metazoa regeneration can be accomplished only by pieces larger than cells, *i. e.*, by an organization of a higher order than that of the cell.

In connection with the question of organization the author makes the pregnant suggestion that it may consist in a system of tensions in the living substance rather than in the polarity or other properties of ultimate units. Such a view would accord well with the facts of regeneration and while 'we cannot picture to ourselves in a mechanical way just how such a system could bring about the suppression of growth in one region and allow the maximum amount in another region,' it not only accords well with the facts but brings a large number of phenomena under a common point of view.

However attractive neo-vitalism may be for

others, it has no peculiar charms for the author who refuses to be stampeded by the apparently intelligent and purposive adaptations of organisms to conditions never experienced before or by the 'proportionate formation of parts' in regenerating embryos and adults. Such phenomena, he thinks, "may be entirely beyond the scope of legitimate explanation, just as are many physical and chemical phenomena themselves, even those of the simplest sort. * * * Even in the physical sciences it would not be difficult to establish a vitalistic principle, or whatever else it might be called, if we choose to take into account such properties as the affinities of atoms and molecules, etc. * * * For my part I see no grounds for accepting a vitalistic principle that is not a physico-causal one, but perhaps a different one from any known at present to chemistry and physics."

Finally, if the adaptations shown in regeneration cannot be explained by natural selection are they to be explained by some teleological principle? To this question the author attempts no direct answer. It is pointed out that not all forms of regeneration are adaptive, *i. e.*, useful, and that 'unless we suppose that some external agent, acting as we do ourselves, directs the formative processes in animals and plants, we are not justified in extending our experience as directive agents to the construction of the organic world.'

These brief extracts do not do justice to the author's argument, but they serve to show his general position on these important questions. The book will undoubtedly take a prominent place among the standard biological works of the world.

E. G. C.

Die Farngattung Niphobolus. By Professor GIESENHAGEN. Jena, Gustav Fischer. 1901. 8vo. Pp. xii + 223. Price, Mk. 5.50.

For a clean piece of monographic work the ideal conditions are a genus of plants of moderate size whose distribution is somewhat circumscribed, and with sufficient adaptability to environment to have induced striking structural characters among the species. Such a condition is represented in the present genus.

To monograph such a genus one needs, in addition to library and herbarium facilities, to be possessed of a good knowledge of technique and above all to know the plants in the field. Such a knowledge of this genus Professor Giesenhagen gained in his travels in Sumatra and other portions of the East Indies and the result is a clearly written monograph of the fifty species of the genus.

The genus forms a rather natural group of ferns which has commonly been included under the genus *Polypodium*, and is easily recognized by the vestiture of star-like hairs covering the laminae. The center of distribution appears to be in India and South China where nearly one half the species (21) are found. Westward the genus extends to Africa (two species), northward to Japan (three species), eastward to Taiti (one species), and southward to Australia (two species). Endemic species are known from most of the larger islands of this region, as Bourbon (one), Ceylon (three), Sumatra (one), Philippines (three), Java (two), Celebes (two) and Borneo (one). One or two species are well known in cultivation under the name *Polypodium Lingua*.

Sixty-five pages of the monograph are devoted to the morphology of the genus and the details of stem and leaf anatomy are clearly brought out, as are the modifications resulting from habitat and environment. This portion of the work is illustrated by a well-selected series of text figures illustrating structures comparatively, which is the only satisfactory method for a work of this sort. The descriptive portions are very clearly and fully made, an entire paragraph being given to anatomical details under each species—a valuable and noteworthy addition to ordinary taxonomic description. The English methods in taxonomy are frequently commented upon with no uncertain sound, being characterized as a classification with 'hands and eyes only' (*sic*) by which they group together widely different species. The work of the English systematists who have hitherto recognized only twenty-three species in this group, is sharply contrasted with the careful work of Mettenius and Kunze in Germany. The author, how-